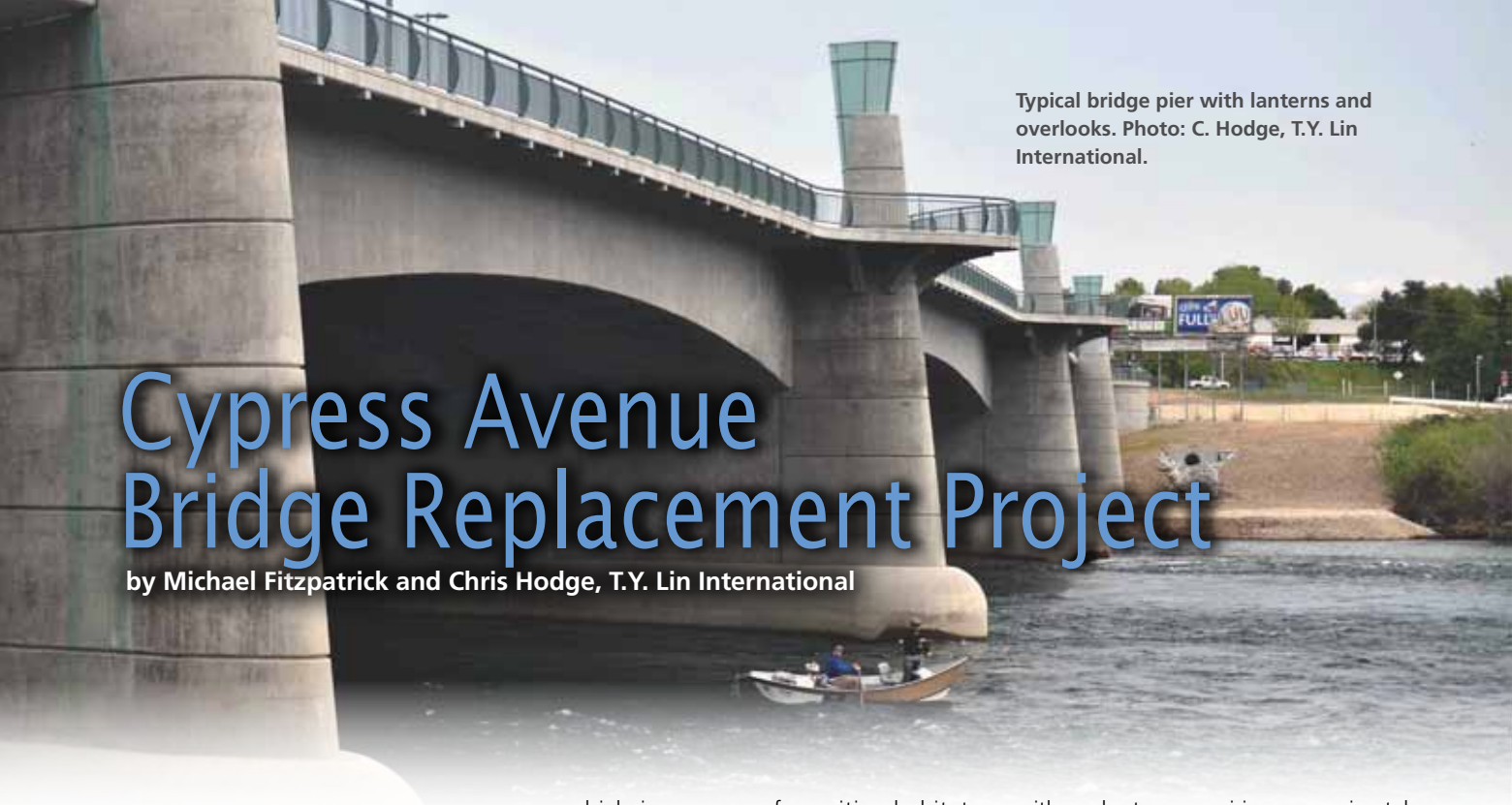


Typical bridge pier with lanterns and overlooks. Photo: C. Hodge, T.Y. Lin International.

Cypress Avenue Bridge Replacement Project

by Michael Fitzpatrick and Chris Hodge, T.Y. Lin International

Redefining the Road to Redding, California

When the city of Redding, Calif., decided to replace two existing, parallel crossings of the Sacramento River in Shasta County, creative engineering solutions and uniquely aesthetic design elements became key priorities for the new iconic bridge that would serve as a gateway to the city. Cypress Avenue is a highly travelled link between Redding and busy I-5. The existing steel girder bridges, built in 1948 and 1968, did not meet traffic demands, pedestrian access width, vertical clearance, foundation scour, and seismic design requirements.

River Environment

The Sacramento River is a major waterway meandering 380 miles through Northern California from its origin near Mount Shasta to its terminus in San Francisco Bay. The bridge crossing location is near the source of the river, which is an area of sensitive habitat for Chinook salmon and steelhead fish species. This section of the river is also used extensively for recreational fishing and boating, as well as nature hikes, and plays a crucial role in the expansion of a hiking trail and riverfront park. Project improvements needed to consider impacts on these natural and recreational resources.

The Cypress Avenue Bridge replaced the two existing bridges with a six-lane signature bridge, including a bike lane and sidewalk on both sides in compliance with city plans for the Cypress Avenue corridor. In addition to the bridge, the project also included significant widening of approach roadways, construction of conventional retaining walls, modification of two adjacent intersections, and reconstruction and realignment of adjacent connnector roads.

Replacement Structure

In order to maintain four lanes of traffic throughout construction, the existing bridges were replaced in three stages, with each stage requiring approximately 1 year. To accommodate the construction stages, the superstructure consists of three parallel box girders. Two of the girders have three cells and one has four. A 3-ft 6-in.-wide closure placement was used between each of the construction stages.

The six-lane replacement structure consists of a 1025-ft-long, 119-ft 6-in.-wide, five-span, haunched, cast-in-place, post-tensioned concrete box-girder bridge on a 9997-ft-radius curved alignment. The span lengths are 180, 200, 230, 230, and 185 ft. The vertical profile over the river includes an 800-ft-long, – 0.25% vertical curve with no superelevation. The deck area provides 9-ft 9-in.-wide areas on each side for sidewalks, lighting, railings, and barriers. There are 8-ft-wide exterior shoulders plus six, 12-ft-wide travel lanes. A 12-ft-wide central area accomodates interior shoulders, a median, and additional lighting.

The haunched box girder depth varies from 8 ft 9 in. at midspan to 14 ft. 9

profile

CYPRESS AVENUE BRIDGE / REDDING, CALIFORNIA

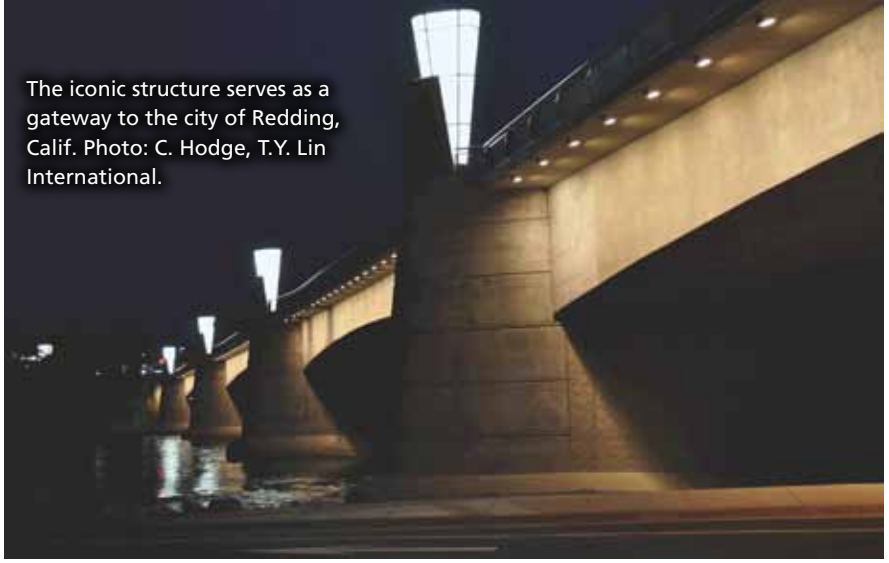
BRIDGE DESIGN ENGINEER: T.Y. Lin International, Sacramento, Calif.

PROJECT ARCHITECTS: T.Y. Lin International and MacDonald Architects, San Francisco, Calif.

PRIME CONTRACTOR: Kiewit, Fairfield, Calif.

LIGHTING AND ILLUMINATION: Illumination Arts LLC, Bloomfield, N.J.

A series of elegant arches connect the bridge to the landscape.

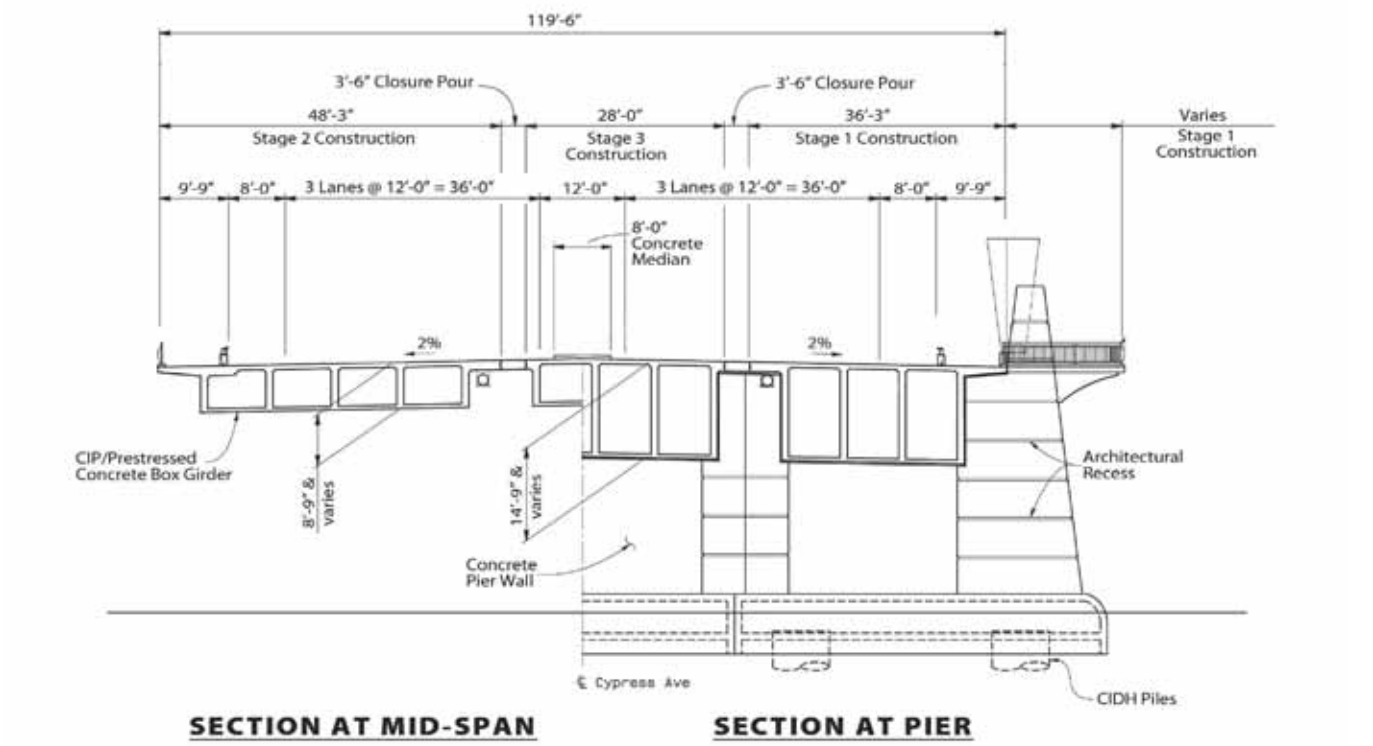


The iconic structure serves as a gateway to the city of Redding, Calif. Photo: C. Hodge, T.Y. Lin International.

in. at the piers. The deck slabs are 8 1/8 in. thick. The soffit slabs are 6 1/4 in. thick and generally deepen to 12 in. thick near abutments and pier locations. The box girder webs are 12 in. thick, and the webs of the exterior girders generally flare to either 15 or 18 in. near abutments and piers.

The superstructure, pier walls with overlooks, pile caps, and cast-in-drilled hole (CIDH) piles all required a concrete compressive strenth of 4000 psi. The abutments and abutment footings required 3600 psi compressive strength concrete. The concrete comprised typical California Department of Transporation mixtures. All reinforcement was Grade 60. Headed bar reinforcement was used to anchor the CIDH piles' reinforcing bars in the footing form.

The post-tensioning tendons were continuous over the full length of the bridge. Stressing was performed from both ends. The post-tesioning was done in three stages corresponding to the three stages of construction. Stage 1 post-tensioning included 10 tendons distributed in the four webs of a three-cell box girder. Six tendons contained 25 strands and four contained 21 strands. The total prestress force was 10,210 kips. Stage 2 used eight tendons with 27 strands, one tendon with 26 strands, and two tendons with 22 strands distributed in the five webs of the four-



Typical section at midspan and at pier. Drawing: T.Y. Lin International (edited).

FIVE-SPAN, CAST-IN-PLACE CONCRETE, POST-TENSIONED, HAUNCHED, BOX-GIRDER BRIDGE / CITY OF REDDING, CALIFORNIA, OWNER

BRIDGE DESCRIPTION: A five-span (180, 200, 230, 230, and 185 ft span lengths), 1025-ft-long and 119-ft-wide, cast-in-place concrete, haunched, box-girder bridge with cast-in-place concrete wall piers, abutments, and foundations, constructed in three-major stages over 4 years

BRIDGE CONSTRUCTION COST: $44 million ($360/ft^2); total project cost, $62 million

A successful consensus-building process shaped the highly stylized lanterns that appear as an extension of the sloped pier walls. Photo: C. Hodge, T.Y. Lin International.

Stage 1 construction utilizing reusable steel footing form. Photo: K. Pope, T.Y. Lin International.

cell box girder. Total prestress force was 12,560 kips. Stage 3 used eight tendons with 27 strands each in the four webs of the three-cell box girder for a total of 9410 kips of post-tensioning. All strands were 0.6 in. diameter.

Piers were fixed to the superstructure at Piers 3 and 4. Piers 2 and 5 and the abutments used combination sliding and spherical polytetrafluoroethylene (PTFE) bearings. The superstructure is supported by single cast-in-place concrete pier walls, 26 ft tall and 4 ft 10 in. thick. The piers are supported by cast-in-place concrete pile caps, 12 ft wide and 9 ft 6 in. deep with rounded ends and top surfaces located at the waterline. The piers are founded on a single row of 8-ft-diameter, CIDH piles that vary in length from 88.5 to 103.5 ft. The tall cantilever, seat-type abutments are founded on conventional pile cap footings on driven steel piles.

Gateway to Redding and the Future

The new Cypress Avenue signature bridge, with its unique aesthetics, improves traffic flow and provides safe pedestrian and bicycle lanes with scenic views, in addition to meeting seismic requirements. This iconic structure serves as a gateway to the city of Redding, spanning the Sacramento River, and pointing west to City Hall.

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Michael Fitzpatrick is bridge architect with T.Y. Lin International in San Francisco, Calif., and Chris Hodge is bridge services manager at T.Y. Lin International in Sacramento, Calif.

For additional photographs or information on this or other projects, visit www.aspirebridge.org and open Current Issue.

Aesthetic Theme through Consensus Building

The bridge was the second phase of the city's master plan to improve Cypress Avenue. It established the route as its main boulevard and home to its cultural centers. The city, therefore, wanted the bridge to enhance the overall plan and to increase pedestrian activity along Cypress Avenue and the new river trail along the Sacramento River.

The project team implemented a four-step process for developing the unique architectural character of the bridge.

Step 1 – By working with a community advisory panel and hosting workshops for the general public, a variable depth box girder was clearly designated as the preferred structure.

Step 2 – The project team's architecture group then developed a general list of the architectural elements to be included as part of the project.

Step 3 – Once the input was compiled from the public workshops and a city-appointed ad hoc committee, the list of special design elements was finalized.

Step 4 – Selection of final colors and architectural shapes and design of the construction details.

The Cypress Avenue Bridge comprises a series of elegant arches, connecting the bridge to the landscape and illuminated at night to create a soft glow over the length of the superstructure.

The main aesthetic features of the bridge are the eight custom-designed, internally illuminated lanterns. These dramatic lanterns are 16 ft tall and constructed of dichroic glass that changes color based on the viewing position. The dichroic glass is ¾ in. thick to reduce the risk of incidental breakage. The lanterns are internally illuminated with cold cathode fixtures and will require re-bulbing only every 20 years. The fixtures can withstand the extreme weather conditions in Redding, which can range from 20 °F in winter to 120 °F in summer. For additional information about the lighting design, see the Creative Concrete Construction article on page 40.

Other architectural elements incorporated into the design add to the distinctive beauty of the new structure. The upstream and downstream edges of the pier wall are rounded and inclined inward from the bottom of the wall to deck level at a 1:8 slope. The sloped wall extends 11 ft 5 in. above the deck to form the housing for the glass lanterns. In addition, the two center piers (Piers 3 and 4) feature reinforced concrete overlooks on each side of the bridge that wrap around the lanterns and provide scenic views of the river at midcrossing. The pier walls and abutments feature a pattern of horizontal banding, with formed reveals divided by large areas of rusticated finish. Three corners of the bridge also include a large, spiral-shaped viewing area. The two abutment viewing areas located at the south edge of the bridge continue this visual theme, with corresponding spiral-shaped stairways from the bridge to the river bank. The bridge sidewalks and overlook areas are paved with a 2½-in.-thick pigmented concrete overlay that features stamped geometric patterns.